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AROUND THE RMA HYDRAZINE FACILITY, DENVER, COLORADO, 18-22 OCTOBER 1976
17-21 JANUARY 1977

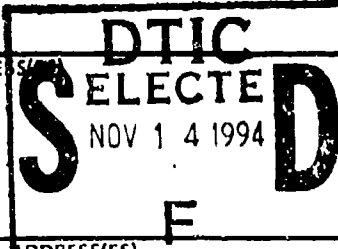
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COOK, L.; GLENN, R.

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ATMOSPHERIC SAMPLES TAKEN IN AND AROUND THE HYDRAZINE FACILITY
INDICATED THE PRESENCE OF HYDRAZINE AND UDMH. SAMPLES TAKEN FROM
WITHIN THE RESPIRATORY EQUIPMENT INDICATED ADEQUATE PROTECTION WAS BEING
PROVIDED BY THE EQUIPMENT PRESENTLY USED. A ROUTINE
MONITORING PROGRAM SHOULD BE ESTABLISHED. APPROPRIATE MEDICAL
SURVEILLANCE AND TRAINING SHOULD BE PROVIDED TO EMPLOYEES
POTENTIALLY EXPOSED TO HYDRAZINE AND UDMH. A MAINTENANCE PROGRAM
SHOULD BE DEVELOPED AND INSTITUTED. FURTHER EVALUATION TO
DETERMINE THE PRESENCE OF NDMA SHOULD BE CONDUCTED.

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 THE ROCKY MOUNTAIN ARSENAL HYDRAZINE FACILITY
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DEPARTMENT OF THE ARMY
U.S. ARMY ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND, MARYLAND 21010

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INDUSTRIAL HYGIENE SPECIAL STUDY NO. 35-0101-77
EVALUATION OF ATMOSPHERIC CONCENTRATIONS OF HYDRAZINE
AND UNSYMMETRICAL DIMETHYLHYDRAZINE IN AND AROUND
THE ROCKY MOUNTAIN AERIAL HYDRAZINE FACILITY
DENVER, COLORADO
10-22 OCTOBER 1976
17-21 JANUARY 1977

ABSTRACT

Atmospheric samples taken in and around the hydrazine facility indicated the presence of hydrazine and UDMH. Samples taken from within the respiratory equipment indicated adequate protection was being provided by the equipment presently used. A routine monitoring program should be established. Appropriate medical surveillance and training should be provided to employees potentially exposed to hydrazine and UDMH. A maintenance program should be developed and instituted. Further evaluation to determine the presence of NDMH should be conducted.



DEPARTMENT OF THE ARMY
U. S. ARMY ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND, MARYLAND 21010

HSE-OI/WT

INDUSTRIAL HYGIENE SPECIAL STUDY NO. 35-0101-77
EVALUATION OF ATMOSPHERIC CONCENTRATIONS OF HYDRAZINE
AND UNSYMMETRICAL DIMETHYLHYDRAZINE IN AND AROUND
THE ROCKY MOUNTAIN ARSENAL HYDRAZINE FACILITY
DENVER, COLORADO
18-22 OCTOBER 1976
17-21 JANUARY 1977

1. AUTHORITY. Letter, SARJH-PA, Headquarters, Rocky Mountain Arsenal, 2 March 1976, subject: Request for Assistance on Determination of a Concentration Profile In and Around the RMA Hydrazine Facility.

2. REFERENCES. See Appendix A for listing of references.

3. ABBREVIATIONS. A glossary of technical terms and abbreviations is included as Appendix B.

4. PURPOSE.

a. To determine worker exposure to hydrazine and UDMH as well as general work area atmospheric levels.

b. To determine hydrazine and UDMH concentrations within close proximity of the facility.

5. BACKGROUND.

a. Activity at the facility consisted of transferring hydrazine and UDMH from storage vessels into rail tank cars, 55-gallon drums, or truck tankers. All hydrazine and UDMH was brought in by railroad tank cars or truck tanks and transferred into the storage facilities. Blending of approximately 50 percent hydrazine and 50 percent UDMH was accomplished at the facility to form Aerozine 50. This mixture was then placed in either railroad tank cars, 55-gallon drums, or truck trailers for shipment.

b. Two surveys of the facility were made. The first survey was conducted during 18-22 October 1976. As a result of the initial visit, it was apparent that the possibility of excessive exposure to personnel existed at the facility. It was also noted that several operational discrepancies existed at the facility. This information and recommendations, based on

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observations and limited data, were presented to the RMA command element during the exit briefing. At that time it was agreed that further evaluation was necessary. The second visit (17-21 January 1977) was made to further, and in more detail, document worker exposure and environmental contamination and to evaluate the effectiveness of implementing the recommendations made during the installation exit interview concerning facility operation.

c. The existing allowable time-weighted average concentration of hydrazine above which personnel should not be exposed is 1 ppm or 1.3 mg/M³ [refer to 29 CFR 1910.1000(a)]. Hydrazine is listed as an industrial substance suspected of carcinogenic potential in man (reference 2, Appendix A). The current TLV[®] for hydrazine is also 1 ppm or 1.3 mg/M³; however, it has been proposed by the ACGIH that the value be lowered to 0.1 ppm. The TLV[®] for 1,1-Dimethylhydrazine (UDMH) is 0.5 ppm, which is also the allowable time-weighted average concentration [refer to 29 CFR 1910.1000(a)]. The median concentration for detection by odor is 3-4 ppm for hydrazine and 6-14 ppm for UDMH.

d. This survey constituted an evaluation of the operation as it pertains to the field of industrial hygiene. This survey should not be construed as an OSHA inspection; however, the criteria used for the basis of this assessment are equal to or more stringent than those contained in the Occupational Safety and Health Act. Operation evaluations were based on observations of the survey personnel during the course of the study and on conversations with operating and supervisory personnel.

e. Samples collected and analyzed by the USAF on 19-20 July 1976 indicated the presence of NDMA in the ambient air near the UDMH storage tanks in the east storage area and near the rail tank car unloading area (reference 5, Appendix A). NDMA is considered carcinogenic and should this compound be identified in the work area, significant operational restraints would be required (refer to 29 CFR 1910.1016). At the present time an acceptable method of collection and analysis for NDMA in the work environment is not available to this Agency. This information was presented to the RMA command element during the 21 January 1977 exit briefing. At that time it was agreed that RMA would contact the USAF and determine if the method utilized during their July 1976 survey was adaptable to work area and personnel sampling.

® TLV - Threshold Limit Value (TLV) refers to airborne concentrations of substances and represents conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effect. TLV refers to time-weighted concentrations for a 7- or 8-hour workday and 40-hour workweek (ACGIH).

METHODS AND PROCEDURES.

a. The analytical scheme used for this study consisted of trapping the hydrazines on H_2SO_4 coated silica gel contained in a glass sampling tube. The hydrazine H_2SO_4 complex was then eluted as an aqueous solution. The addition of 1-furaldehyde in 0.5 M sodium acetate allowed the formation of a hydrazine which, in turn, was extracted into ethylacetate and analyzed by gas chromatography. Field samples were then compared with prepared standards.

b. MSA[®], Model G, personnel pumps were used to collect the samples. Sampling rates through the silica gel tubes were approximately 1 liter per minute and sample volumes of at least 30 liters were collected.

c. A MSA protective mask, similar to those used by the operating personnel, was modified to allow sample collection within the mask. The mask was tested to insure that integrity was maintained after the addition of the sampling part. Personnel pumps were placed on operating individuals and samples were obtained simultaneously from within the mask and from the area outside the mask.

d. It was noted, during the October 1976 survey, that at specific operations the M9A1, Chemical-Biological, Special Purpose Gas Mask with the M-11 canister was utilized. As a result of these observations, an M9A1 gas mask was modified to allow an atmospheric sample to be withdrawn from inside protective mask. Simultaneous samples were taken from inside the mask from the area directly outside the mask.

e. Appendix C indicates the approximate location of the sampling sites.

7. FINDINGS AND DISCUSSION.

a. The drum filling operation consisted of placing a drum on the scales located in the Drum Load Station. A dual inlet filling head was then screwed into the large bung of the 55-gallon container. Hydrazine or UDMH transfer lines were attached using quick connect couplings to one side of the filling head. The other inlet was connected to the N_2 line. The drum was filled with N_2 prior to the filling operation. After the nitrogen purge, the fuel; hydrazine, UDMH, or Aerozine 50, was added until the desired weight was

[®] MSA is the registered trademark of Mine Safety Appliances Company, 400 Penn Center Boulevard, Pittsburgh, PA 15235.

obtained. A nitrogen blanket was added, the filling head removed, and the bung tightened. The top of the drum was washed with water to remove residual hydrazine or UDMH. A forklift was then used to move the drum to the storage area. The time required to fill a drum varied from 10 to 20 minutes. Personnel performing the drumming operation wore the following personal protective equipment: rubber gloves, rubber aprons, rubber boots, and a MSA Ultravue facepiece protective mask with a rocket propellant canister, M15A1. (Comment: Neither the US Bureau of Mines or MESA/NIOSH have established performance requirements for testing and certifying this type of gas mask system). The operator of the forklift wore a M9A1 gas mask when transporting the drum.

b. When filling rail tank cars or trailer tanks, a moveable, flexible transfer line with a flanged connection was attached to the inlet of the tanker. The same purge, fill, and nitrogen blanket cycle was utilized during the loading operation. After making the connection and starting the fill operation, personnel exit the area. It was observed that approximately 30 minutes is required to connect or disconnect the tank cars. During the October survey it was noted that personnel wore either the MSA or the M9A1 protective mask. During the October exit interview, it was recommended that all operating personnel wear the MSA protective mask when performing filling operations because of the larger sorbent (charcoal) capacity. This recommendation had been implemented and was verified by observations during the January survey. It was noted during the January survey that maintenance personnel were utilizing the M9A1 protective mask when performing repair on equipment. Concern over the use of this equipment was expressed by the maintenance personnel, and as a result, samples were taken inside and outside the protective mask during a repair operation. These data are presented in Appendix D. It was reported by the maintenance personnel that the odor of hydrazine was present inside the protective mask. Samples withdrawn from inside the mask indicated the levels were less than 0.001 ppm. However, this is an integrated sample over the 23-minute sampling period and a leak around the face seal could allow concentrations at or above the odor threshold of hydrazine or UDMH to occur for very short periods of time. The integrated sample indicated the time-weighted average exposure was well below the acceptable concentration. There was no evidence of the M-11 canister breaking through. [Comment: the M-11 canister has been shown to have a service life of 26 minutes when challenged with a concentration of 4.8 mg/liter (or approximately 4800 mg/M³) of hydrazine (anhydrous) at a flow rate of 32 liters/minute].

† Edgewood Arsenal Special Publication, Robinson, D., EASP 1800-10, "Summary of Protection Provided by Military Masks Against Various Military and Nonmilitary Agents" (January 1973)

c. During the October survey two hydrazine transfer pumps were observed leaking and a lack of maintenance on equipment was apparent. When hydrazine operations were being conducted, the odor of hydrazine or UDMH was noted outside the general work area. A similar odor was noted in the work area when operations were not being conducted. No respiratory protective equipment was utilized by operating personnel when entering the work area when operations were not being conducted and only those personnel performing the operations wore respiratory protection when filling was occurring. This information and recommendations for developing SOP were made during the October exit interview. During the January survey a significant improvement in the maintenance of the equipment was noted. The leaking pumps had been repaired and new transfer hoses had been installed. SOP which included the wearing of respiratory protective equipment when entering the work area were being observed. The work area was defined by establishing a line inside which all personnel would wear a mask. Additional sampling conducted in January substantiated the fact that concentrations exceeding the TLV could be found in the work area when there were no operations being conducted (see Appendix D). However, no significant concentrations outside the established workarea or maskline were noted during routine operations.

d. Results of general area atmospheric samples are presented in Appendix D. The data indicates that atmospheric samples taken in January at the same locations were lower than those collected in October. This indicates that the repairs made were effective in reducing the concentration in the work area. During the October survey samples taken at the perimeter indicated the presence of UDMH or hydrazine. Samples taken during the January survey did not indicate the presence of these compounds at the perimeter; however, different meteorological conditions would be expected to affect the concentrations.

e. Results of the personnel samples are presented in Appendix E. This data shows the atmospheric concentrations outside and inside the protective masks during various operations. These data indicate the atmospheric concentration is greatest outside the mask when drumming operations are being conducted. One sample collected from within the mask indicated the concentration in the mask was 0.03 ppm UDMH, although this is below the TLV it indicates the face seal on the mask was broken. All other samples were well below the allowable exposure limit.

f. Personnel employed at the facility expressed concern about the quality of the medical examinations provided, and it was apparent that the employees had not been sufficiently oriented to the hazards associated with hydrazine and UDMH.

8. RECOMMENDATIONS.

a. A routine monitoring program should be established to determine and document the atmospheric concentrations of hydrazine and UDMH in the work area at various distances from the work area to include the hydrazine facility perimeter. This should be accomplished under various meteorological conditions and operating parameters. This program should be established as expeditiously as possible. This recommendation was presented to the RMA command element during the January exit briefing (refer to paragraph 5b and 29 CFR 1960, Safety and Health Provisions for Federal Employees).

b. Provide a MSA protective mask with a M15A1, rocket propellant canister (NSN-4240-00-902-5516) to all maintenance personnel for use when working in the area. Insure all personnel who enter the work area are wearing respiratory protective devices. This recommendation was presented to the RMA command element during the January exit interview (refer to paragraph 7a).

c. Routine preventive maintenance procedures should be developed and implemented for equipment used at the facility (refer to paragraph 7c).

d. Determine the feasibility of using the USAF method of determining the presence and or concentration of NDMA at the transfer facility. If NDMA is identified, a reevaluation of the facility will be required to insure compliance with OSHA regulations. This information was discussed during the January exit interview. (refer to paragraph 5e and 29 CFR 1910.1016).

e. Provide pertinent medical examinations to all employees potentially exposed to hydrazine or UDMH. This examination should include the following: SGOT, SGPT, Alk Phosph, CBC, BUN, Creatinine, GGTP, UA, and EEG (reference 4, Appendix A). In addition chest x-rays (PA and lateral) should be taken with each medical examination. Because of the potential carcinogenicity of hydrazine and UDMH, the additional following examinations are recommended: LDH, sputum cytology, and urine cytology. Each individual required to wear a respiratory protective device should receive a pertinent medical examination prior to issuance of the device. This evaluation should include an assessment of the individual's ability to use such devices when performing normal duties. The individual's health status should also be reviewed periodically to assess both the continued ability to wear respiratory protective devices and to ensure that the individual has not been adversely affected by exposure to toxic substances. The frequency of the examinations should be established by the local physician. Recommended frequency of examination is annually for those exposed less than 10 years and semi-annually thereafter.

f. All employees who are potentially exposed to hydrazine or UDMH should receive instruction as to the hazards associated with the compounds. This

Documentation should include information on the acute and chronic physiological effects of exposure to hydrazine and UDMH (refer to 7E).

g. Long-range plans to improve the facility and implement engineering controls to control the release of hydrazine and UDMH should be developed [29 CFR 1910.134(a)].

9. GENERAL. Implementation of the recommendations of this report is essential to provide adequate industrial hygiene controls for protecting the health of the workers at the operation. In addition, the medical facility providing occupational health services should use the findings of this report to insure that workers with potentially hazardous exposures are provided pertinent medical monitoring examinations.

10. TECHNICAL ASSISTANCE. Should the USAF method for collection and analysis of NDMA be unacceptable, additional assistance will be provided upon request. In accordance with paragraph 1-5, AR 40-5, Health and Environment, 25 September 1974, requests for further services should be directed through appropriate channels to Commander, USA Health Services Command, ATTN: HSPA-H, Ft Sam Houston, TX 78234.

Larry R. Cook

LARRY R. COOK

Industrial Hygienist

Industrial Hygiene Division

ROBERT E. GLENN

MAJ, MSC

Environmental Science Officer

Industrial Hygiene Division

APPROVED:

KENNETH W. VORPAHL

MAJ, MSC

Chief, Industrial Hygiene Division

JAMES A. HATHAWAY, M.D.

LTC, MC

Director, Occupational and
Environmental Health

APPENDIX A

REFERENCES

1. Title 29, Code of Federal Regulations (CFR), 1976 ed., Part 1910, Occupational Safety and Health Standards.
2. Title 29, Code of Federal Regulations (CFR), 1976 ed., Part 1960, Safety and Health Provisions for Federal Employees.
3. American Conference of Governmental Industrial Hygienists, TLVs[®] Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes for 1976.
4. USAEMH, Medical Surveillance Guide (Guide for Job Related Examinations), January 1975 with Appendix G, Recommendations for Periodic Job Related Examinations for Selected Occupations - April 1975.
5. Letter, SFQT, Headquarters, San Antonio Air Logistics Center (AFLC), Kelly Air Force Base, Texas, 13 October 1976, subject: NDMA Analysis at RMA.

APPENDIX B

GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

Alk Phosph	Alkaline Phosphatase
ACGIH	American Conference of Governmental Industrial Hygienists
BUN	Blood Urea Nitrogen
CBC	Complete Blood Count
EKG	Electroencephalogram
GGTP	Gamma Glutamyl Transpeptidase
H ₂ SO ₄	Sulfuric Acid
LDH ⁴	Lactic Dehydrogenase
M	Molar
MESA	Mine Enforcement Safety Administration
mg	milligrams
mg/M ³	milligrams of contaminant per cubic meter of air
N ₂	Nitrogen
NDMA	N-nitrosodimethylamine
ND	None detected
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PA	Posteroanterior
ppm	Parts per million
RA	Rock Mountain Arsenal
SGOT	Serum Glutamic Oxaloacetic Transaminase
SGPT	Serum Glutamic Pyruvic Transaminase
SOP	Standing Operating Procedures
UA	Urinalysis, including microscopic examination
UDMH	Unsymmetrical dimethylhydrazine
USAEHA	US Army Environmental Hygiene Agency
USAF	United States Air Force

APPENDIX C AT THE ILLUSTRATOR

Location	Operation	Atmospheric Concentration (ppm)		Comment
		Hydrazine	UDMH	
Near truck tank	do		0.41	19 Oct 76, afternoon, slight breeze from
Near eye lavage (10)	do		0.87	NE approximately 5 mph temperature 48°F
5 ft east of Drum Load Station (5)	do		1.66	
3 ft from fill nozzle in Drum Load Station (5)	do		0.96	
7 ft south of Drum Load Station (3)	do		0.55	
3 ft from fill nozzle in Drum Load Station (5)	do		ND	20 Oct 76, morning wind from south-southeast at approximately 7 mph temperature 39°F
15 ft NE of Drum Load Station (4)	do		0.004	
Blend Metering House Panel (8)	do		0.71	
East Railcar Filling Station (9)	do		0.46	
North railsiding ft from fence (10)	do		0.03	
West end Storage Tank US-1 (11)	do		ND	
East end Storage Tank US-1 (12)	do		ND	
Tank CS-1 Storage Area (13)	Filling railcar with Aerozine 50	ND	ND	
do	do	ND	ND	
North perimeter fence, 5 ft elev (14)	do	0.03	0.06	

Location	Operation	Atmospheric Concentration (ppm)		Comment
		Hydrazine	UDMH	
do	do	ND	ND	
do	do	ND	0.01	
West side railroad track (17)	do	ND	ND	
North of railcar (18); east side railroad track (19)	do	ND	ND	
15 ft NE of Drum Load Station (14)	do	0.04	0.21	
NE of Blend Metering House (9) near railroad car	do	<0.01	0.02	
Blend Meter House Control Panel (8)	do	0.30	0.25	
100 ft east of Blend Metering House (24)	do	ND	ND	21 Oct 76
Fence near north gate (15)	do	0.005	0.0004	
Top of railroad loading platform (9)	do	ND	0.004	
Near safety shower (10)	do	0.04	0.08	
Near center pump (20)	do	0.005	0.034	
Near center pump switch control (20)	do	0.003	0.068	
SW corner of east tank car load station (9)	do	0.002	0.062	
Blend Metering House Control Panel (8)	Filling tank car	0.19	0.19	

Location	Operation	Atmospheric Concentration (ppm)		Comment
		Hydrazine	UDMH	
North side of Blend Metering House near railroad tracks (21)	Cleaning filter on feedlines	0.23	0.54	20 Oct 76,
Near eye lavage (4)	do	0.05	0.15	Wind from the east approximately 6 mph temperature 59°F
West of Blend Metering House (22)	do	0.23	0.33	
Blend Metering House Control Panel (8)	do	0.64	1.01	
Top of Blend Metering House (8)	do	0.10	0.39	
Truck Tank Facility (9)	do	<0.01	0.057	
East of Blend Metering House (23)	do	0.011	0.068	
East Storage Area near eye lavage (24)	Filling tank car	ND	ND	21 Oct 76
Near control stand (25)	do	ND	ND	
West fence near gate (26)	do	ND	ND	
South fence near gate (27)	do	ND	ND	
Near truck tank loading platform (29)	Loading truck tankers with Aerozine 50	ND	ND	18 Jan 1977 Winds S-SW 5 mph
Blend Metering House (8)	do	<0.01	<0.001	
Near truck tank loading platform (8)	do	ND	<0.001	do
Gate valve near Facility entrance (30)	do	<0.01	0.02	do

Location	Operation	Atmospheric Concentration (ppm)		Comment
		Hydrazine	UDMH	
Bank CF-1 storage area (13)	do	ND	ND	
Car gate east of railroad (31)	do	ND	ND	
Approximately 30 feet E of fill nozzle (32)	do	ND	ND	Winds west 10 mph, Temp 40°F
E corner of Bldg No. 760 (33)	do	ND	ND	
SE corner of truck bank load area (34)	do	ND	ND	
SE corner of truck bank load area on yellow mask line (35)	do	<0.01	ND	
Truck tank loading at Upper Level (29)	do	<0.01	ND	
SE corner of drum yardstand (36)	do	0.02	ND	
SE corner of drum yardstand (37)	do	<0.01	ND	
Near N ₂ tank (38)	do	ND	ND	
Near Bldg 755 (7)	No operation	<0.01	ND	Background samples 19 Jan 77
Blend Metering house (8)	do	0.42	0.03	
NW Corner of fence (39)	do	<0.01	ND	
Near Blend Metering House (8)	do	do	do	
Bldg No. 761 (6)	do	do	do	
Truck tank loading at (29)	do	do	do	

Location	Operation	Atmospheric Concentration (ppm)		Comment
		Hydrazine	UDMH	
SW corner of fence (40)	do	do	do	
SW corner of waste sump (41)	do	do	do	
Truck tank loading ramp (29)	Drumming hydrazine	<0.01	-	20 Jan 1977, Morning wind calm 40°F
7 ft south of Drum Load Station (3)	do	0.39	-	
7 ft South of Drum Load Station (3)	do	0.10	-	Bubbler method results
3 ft from fill nozzle in Drum Load Station (5)	do	0.25	-	
15 ft south of fill nozzle (42)	do	0.01		
15 ft south of fill nozzle (42)	do	0.24		Bubbler method results 20 Jan 1977, afternoon
7 ft south of Drum Load Station (3)	do	ND		
3 ft from fill nozzle in Drum Load Station (5)	do	<0.001		
15 ft south of Fill nozzle (42)	do	<0.001		
15 ft south of fill nozzle (42)	do	0.03		Bubbler results
7 ft south of Drum Load Station (3)	do	0.02		Bubbler results
Approximately 20' North of Operation (18)	Maintenance Operation Equipment	0.073	ND	Wind calm Temp 40°F

Location	Operation	Atmospheric Concentration (ppm)		Comment
		Hydrazine	UDMH	
Approximately 20' NE of Blend Metering House (19)	do	0.022	ND	Maintenance performed by maintenance personnel using the M9 gas mask with the M-11 cartridge.
Approximately 60' NE of Blend Metering House (43)	do	0.19	0.35	
3 ft from fill nozzle in Drum Load Station (5)	Transfer of Aerozine to new drums	0.05	0.11	21 Jan 1977, afternoon
do	do	<0.001	ND	Bubbler sample
Near eye lavage (10)	do	ND	ND	
40 ft North of Bldg No. 759 (43)	do	ND	ND	
10 ft South of fill nozzle (43)	do	0.04	ND	
do	do	0.014	ND	Bubbler sample
Front of Bldg No. 759	do	<0.001	ND	

APPENDIX E

RESULTS OF ATMOSPHERIC SAMPLES
PERSONNEL

TABLE 2. RESULTS, 18-22 OCTOBER 1976

Location	Operation	Atmospheric Concentration (ppm)		Comment
		Hydrazine	UDMH	
Outside MSA Mask	Loading Truck Trailer with Aerozine 50	0.22	0.14	Simultaneous sample during operation
Inside MSA Mask	do	ND	ND	Simultaneous sample during connection and disconnection operation
Outside MSA Mask	Drumming hydrazine	1.15		
Inside MSA Mask	do	ND		Simultaneous samples taken on operators
Outside MSA Mask	do	1.64		
Inside MSA Mask	do	ND		
Outside MSA Mask	do	0.22		
Inside MSA Mask	do	<0.001		
Outside MSA Mask	do	1.98		
Inside MSA Mask	do	ND		
Inside M-9 Mask	Replacing gasket in a transfer line	-	ND	Simultaneous samples taken on maintenance personnel.
Outside M-9 Mask	do		1.10	
Inside M-9 Mask	do		<0.001	
Outside MSA Mask	Transfer of Aerozine 50	0.71	1.71	Simultaneous samples taken on operators
Inside MSA Mask	do	<0.001	ND	

TABLE 1. H. H. Co., 10-22 OCTOBER 1976

Location	Operation	Atmospheric Concentration (ppm)		Comment
		Hydrazine	UDMH	
Bldg 761 Drum Load Station	Drumming UDMH		0.20	Outside the respiratory protective equipment
do	do		ND	Inside the respiratory protective equipment
do	do		3.40	Outside the respiratory protective equipment
do	do		0.45	Outside the respiratory protective equipment
do	do		ND	Inside the respiratory protective equipment
do	do		0.56	Outside the respiratory protective equipment
do	do		ND	Inside the respiratory protective equipment
do	do		4.61	Outside the respiratory protective equipment
do	do		0.03	Inside the respiratory protective equipment
do	do		2.95	Outside the respiratory protective equipment
do	do		ND	Inside the respiratory protective equipment
2 ft south of the Blend Metering House	Cleaning filter	1.6	1.61	Outside the respiratory protective equipment
do	do	ND	ND	Inside the respiratory protective equipment
do	do	0.31	0.30	Outside helpers respiratory protective equipment M9 protective mask
Bldg 761 Drum Load Station	Drumming UDMH		0.23	Outside the respiratory protective equipment
	do		ND	Inside the respiratory protective equipment
	do		0.36	Outside the respiratory protective equipment
	do		ND	Inside the respiratory protective equipment
Railroad Tank Car Facility	Disconnecting filling apparatus from railroad tank car	0.99	1.33	Outside the respiratory protective equipment
		ND	ND	Inside the respiratory protective equipment

*SS - Simultaneous Samples